

# Energy 2004

# Round One!



# **Energy 2005**

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## **Open Systems**

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# Open Systems

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- In Round 1 at Energy 2004, we asked the question, “Open Systems, Yes or No?”
  - We looked at the risk versus reward
  - We introduced some basis concepts
  - We made some comparisons between the LON technology and BACNet technology

# Open Systems

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- In Round 2 today we will take a closer look at open systems based on the LonWorks technology
  - The architectures
  - The benefits, desired versus delivered
  - The execution challenges
  - The operational challenges
- Potential future discussions
  - The BACNet technology
  - Emerging IP technologies

# What are we looking for?

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- Facility owner/operators are looking for:
  - Sound functionality
  - Flexibility in product sourcing
  - Competitive bidding
  - Multiple service options
- The goal is to achieve the last three without sacrificing the first one

# Open Systems – A Review

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- An essential ingredient of an open system is the use of an open protocol.
- Protocol refers to the structure of data that is being communicated.
  - It can define speed, types of media supported as well as the format of the data.
  - The definition of services can also be defined as part of a protocol.
- The word “open” implies that the protocol is available for use by multiple vendors without restrictions.

# Open Systems – A Review

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- Within a DDC system we have three different requirements for communication.
  - Device to device at the field bus level. This may include communication over the IP layer
  - From the field level devices to the server PC
  - From Operator Workstations to the server PC
- We will be reviewing each of these as this presentation unfolds.

# Open Systems – A Review

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- The benefits of “opening” a system is not an all or nothing concept
- The benefits of using open protocols can be delivered in increments
  - Component level
  - Systems level
- The component level is the low hanging fruit while the systems level requires a ladder.

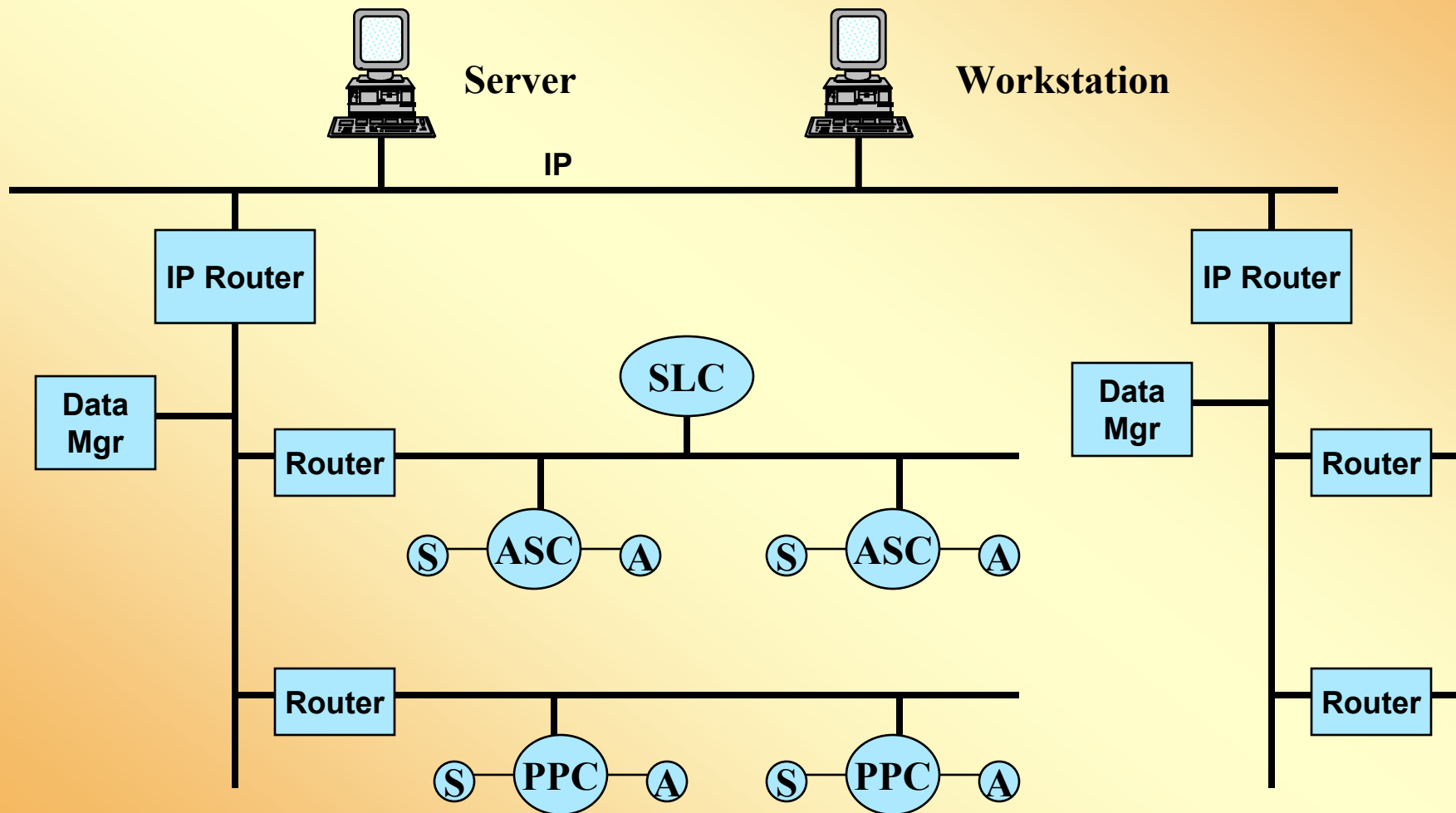


# System Architecture-Lon

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- If we review the product offerings by the major DDC vendors we find two different approaches to architecture
- Concept 1
  - LonTalk at all layers of the architecture
- Concept 2
  - LonTalk at the field bus only
  - BACNet or proprietary at the IP layer

# Concept 1

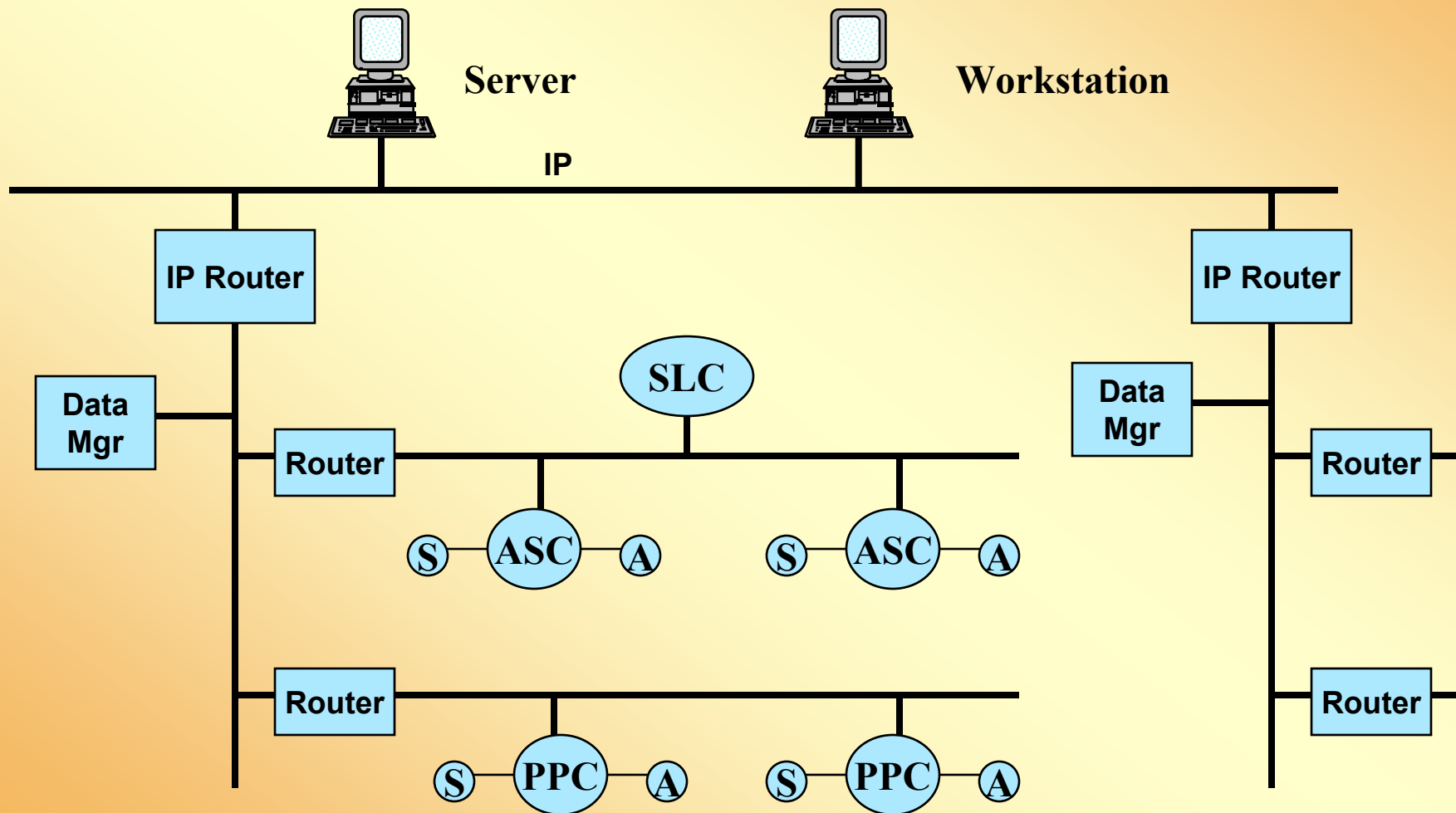


# The Abbreviations

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- IP: Internet Protocol
- Data Mgr: Data Manager
  - Time Schedules, Trend Logs, Alarm Processing
- ASC: Application Specific Controller
  - VAV, Fan Coils, Drives and other preprogrammed devices
- SLC: Supervisory Logic Controller
  - Supervisory Logic Support
  - No physical I/O
- PPC: Programmable Process Controller
  - Fully programmable controller for large applications

# Concept 1

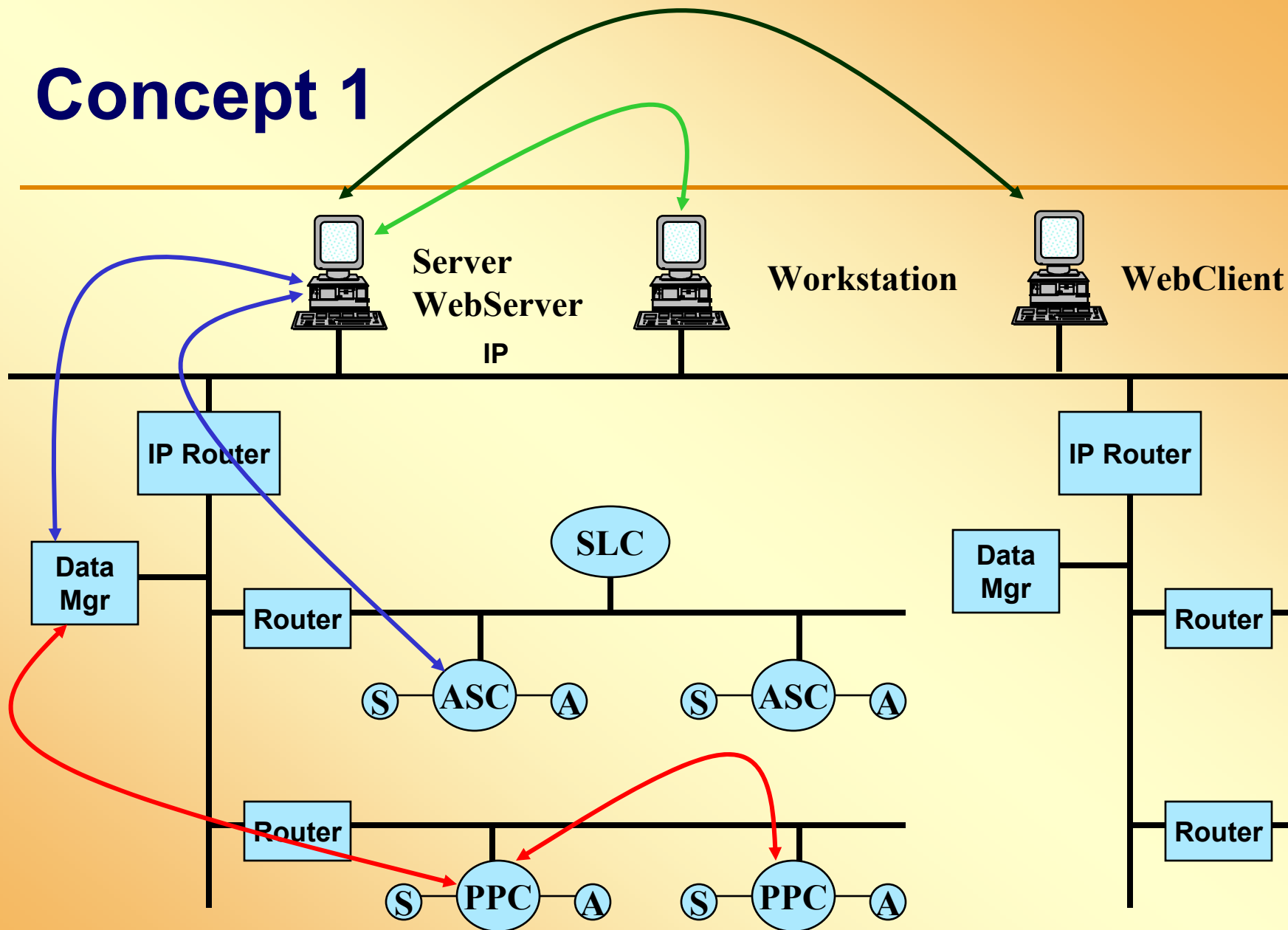


# Some Key Points

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- Protocol at field bus is LonTalk
- Protocol at IP layer is LonTalk
- Data Manager is a field level device
- Each IP connection will support several hundred devices by using field bus routers

# Concept 1

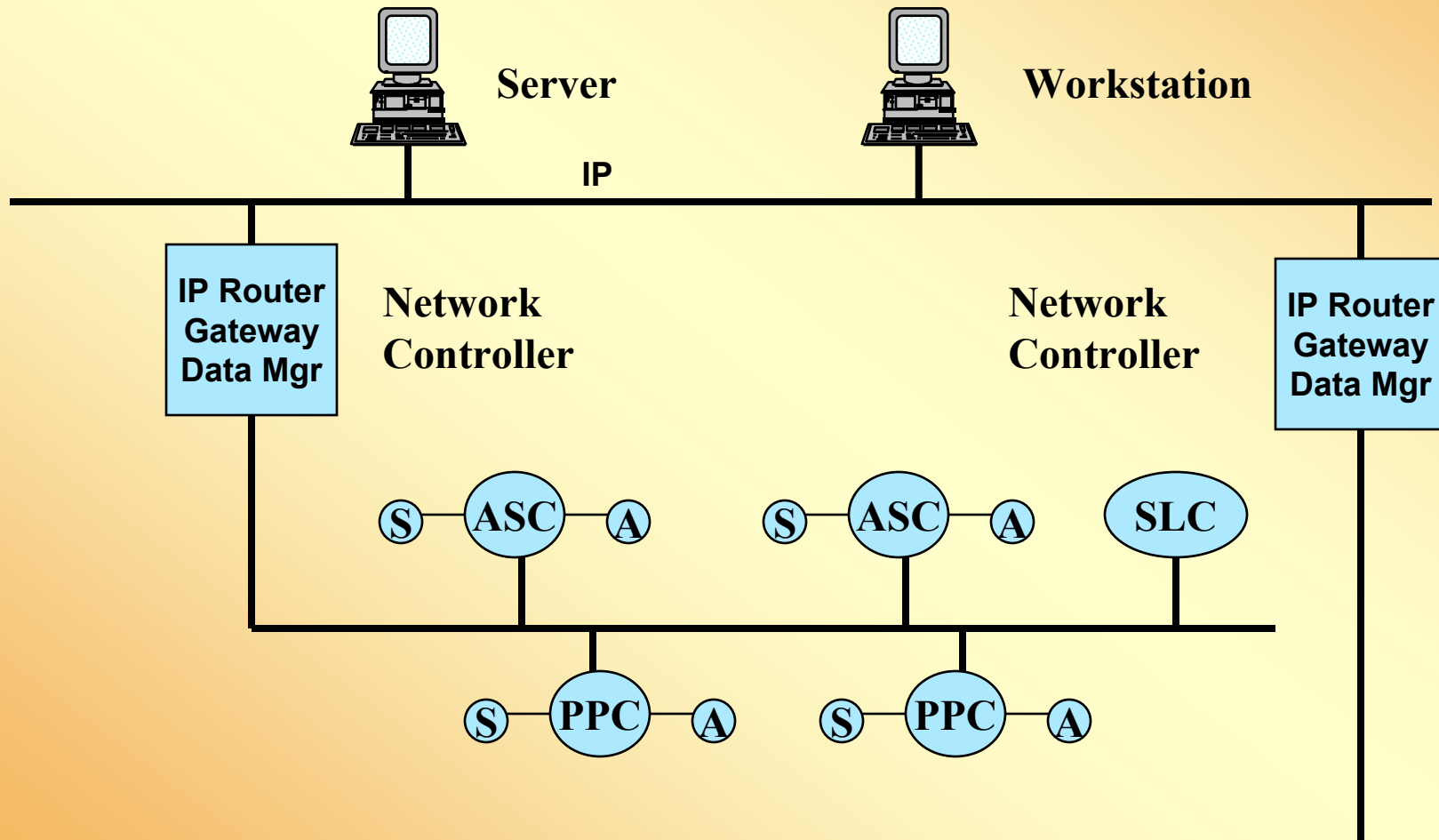


# Concept 1-Communications

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- LonTalk: The Red and Blue
- Proprietary: The Green
  - The Workstation has vendor unique software
- Web Based: The Black
  - The Web Client uses a web browser to access data from the web server

# Concept 2



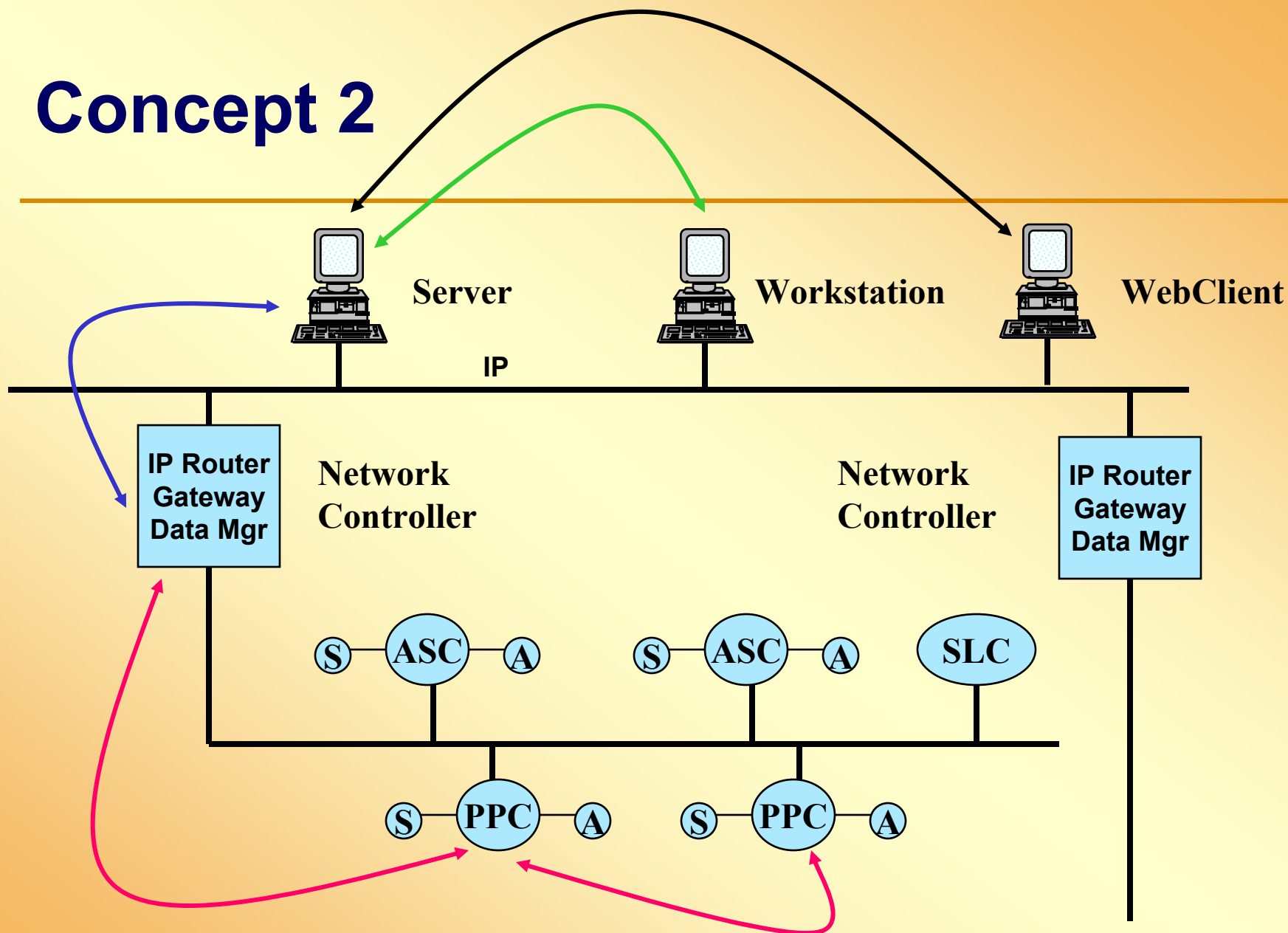


# Some Key Points

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- Data Manager and IP Router functions have been combined
- There is a protocol translation in the Network Controller from LonTalk to either BACNet or proprietary
- Field bus routers are not supported so each IP connection is limited to 126 devices

## Concept 2



# Concept 2-Communications

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- LonTalk: The Red
- BACNet or Proprietary: The Blue
- Proprietary: The Green
  - The Workstation has vendor unique software
- Web Based: The Black
  - The Web Client uses a web browser to access data from the web server

# Component Level

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- Proprietary systems have historically imposed two critical limitations on facility owners.
  - For commodity level devices we were forced to stay with a single vendor
  - For integration to HVAC equipment such as chillers, drives, power monitoring we were forced into the world of custom gateways.

# Component Level

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- The evolution of the LonWorks technology at the component level has been very strong.
- Regardless of the architecture chosen, the commodity level controllers can be vendor independent.

# Component Level

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- The number of third party devices being produced that communicate with LonTalk has increased significantly over the last 10 years.
- Lighting control, power monitoring, HVAC equipment, specialty sensors, drives, networked actuators, unitary equipment controllers are all available using open protocol communication.

# The Benefit

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- Troublesome gateways are eliminated
  - Costs are lowered
  - Difficulty of implementation is reduced
  - Difficulty of upgrading is minimized
- Better quality control systems
  - Specialty manufacturers can dominate with the associated improvement in features and reliability
  - Your controls system service providers can deliver a superior solution when they can take advantage of the products that use open protocols

# The Challenges

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- With LonWorks, the implementation risks are very low
- The communication details to these devices is typically very standard
- The LonMark International Association has done a good job of setting standards and the industry has done a good job of following the standards.
- In the BACNet camp, the BACNet Testing Laboratory (BTL) is working on this same concept.



# Component Level Summary

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- Benefits to the consumer far outweigh any risks at the component level.
- Another important factor is that the DDC vendors do not feel threatened by this level of open systems.
  - Gateways never made any profits for a DDC vendor
  - Margins on application specific devices are very low..the profit is in the installation and setup...so losing the product sale but not the installation contract and service work is acceptable to DDC vendors.

# System Level

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- Let's now raise our expectations with respect to open systems and use a ladder.
- First we shall define a system as a collection of control components typically provided by a single vendor to meet the control needs of a building or a portion of a building. This collection of components could include some interoperable components as described by our level 1 concept.

# The Controls Environment

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- You have an Enterprise Level System (HMI) for your operator interface.
  - This is the IP level of the architecture
  - The servers, workstations, web servers, web clients, IP routers or network controllers and data managers belong to your enterprise level vendor.
- You have a number of building control systems connected to the enterprise level system.
  - They may have been provided by the enterprise level vendor.

# The Controls Environment

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- You have a requirement to add a new building to the overall system.
- You want the capability to consider systems from multiple vendors.
  - A new vendor may offer a specific feature set that uniquely meets your requirements
  - You want to use competitive bidding as a mechanism to ensure cost control (this is the most common interest)

# Implementation

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- There are three phases to adding the new system and this is where we have the most to learn.
  - The new system must be completed “stand alone” with basic operator interface capability and “*the engineering of the new system must be compatible with the post connection requirements*”.
  - The connection of the new system to the existing enterprise level system is made.
  - A concept of operations has to be implemented.

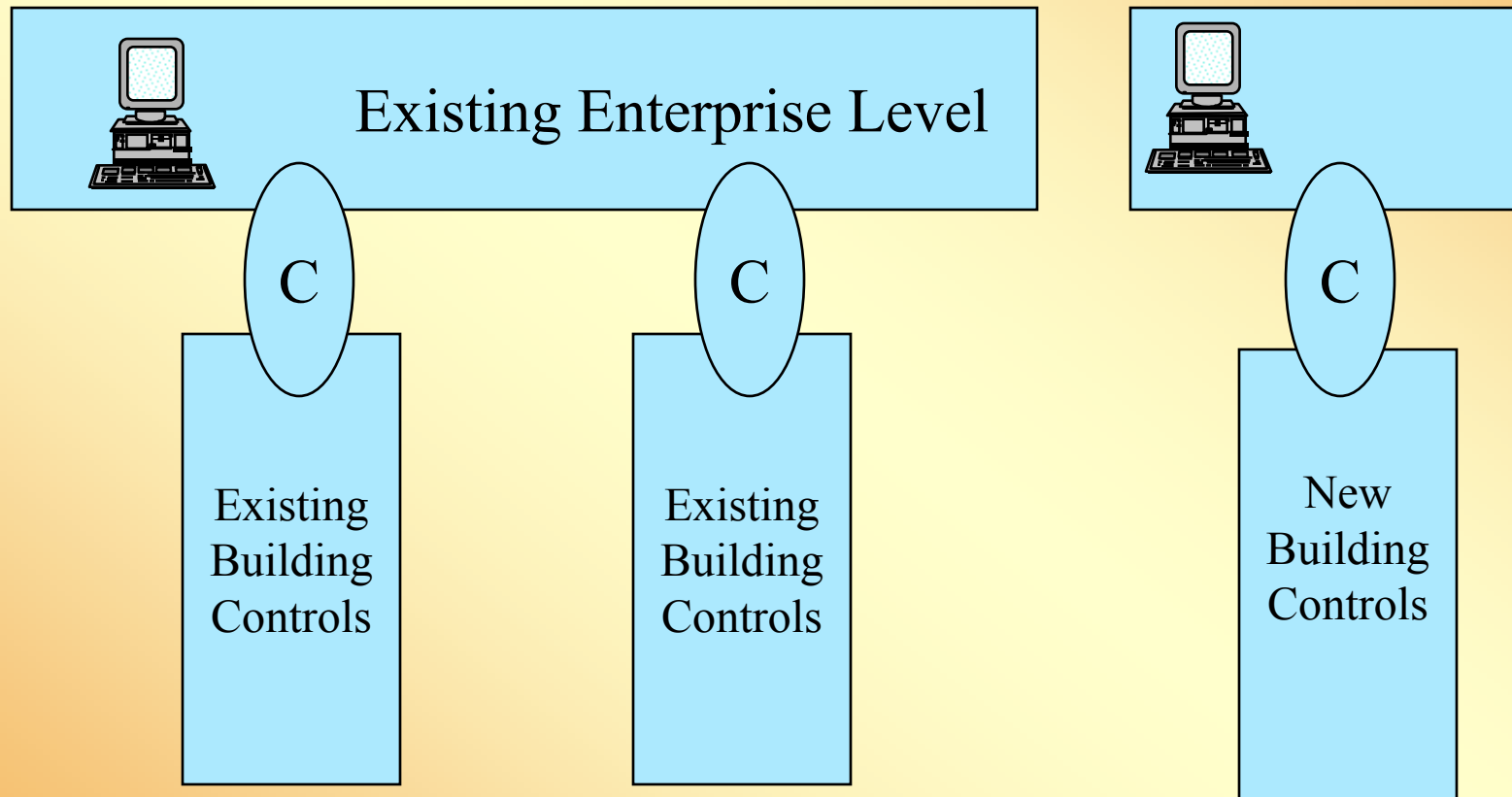
# First Phase

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- From a legal and contractual stand point it is imperative that the new building contractor be required to “complete” the new system.
  - There must be a “service oriented” HMI in place
  - Checkout and commissioning must be completed and accepted.
- You do not want to find yourself in an environment where two contractors are pointing fingers at each other.
  - Once the primary HMI contractor touches the new system, the second contractor is going to plead “they screwed it up”.

# A Diagram Before Connection

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**C: Connection Point**

# Critical Planning Factors

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- Even though the new system is being installed and commissioned “stand alone”, there are some factors that must be considered to avoid post connection problems.
  - Addressing scheme (network management)
  - Post connection functionality
  - Transfer of information from new system contractor to enterprise level vendor.



# Addressing Scheme

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- When Lon based systems are commissioned, all devices are assigned addresses. HMI's interact with the devices by knowing the device addresses.
- When the connection of the new system is made, it may be necessary to change the addresses of the new system devices to avoid conflicts with the addresses of the existing system devices.

# Addressing Scheme

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- When this happens the new system contractor must be required to re-establish the link between his devices and his portal or HMI. This must be a contract requirement (sort of like an off season test).
- In some environments address conflicts will not be an issue but there has to be a plan.

# Post Connection Functionality

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- This is extremely important!
- Is it possible for the new system vendor to calibrate a sensor from his HMI, but after connection, the enterprise level vendor does not have this capability?
- Is it possible for the new system vendor to manually command a point in his system, but after connection, the enterprise level vendor does not have this capability?

# Post Connection Functionality

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- During the installation and startup of the new system, the new system vendor will use his time schedules to operate the new system.
- After connection, it will be necessary to transfer time based control to the enterprise level vendor. Has this switchover concept been engineered into the applications?

# Post Connection Functionality

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- It is extremely important to define upfront the functionality that will exist from the enterprise level HMI after the connection is made.
  - Location and editing of time schedules (transfer concept)
  - Location and extraction of trend data
  - Alarm handling
  - Manual override capabilities
  - Access to calibration and tuning parameters
  - Access to application parameters
  - Dynamic data to be accessible

# Post Connection Functionality

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- Dealing with these critical factors in the specification is not difficult but it is very necessary.
- Verification that things have been done correctly can be accomplished by a review of the “interface document”.
- This interface document also meets the needs of our third area which is transfer of information from the new system vendor to the enterprise level vendor.

# The Interface Document

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- This is a document that is prepare for each device in the new system.
- Key areas include:
  - Addressing information
  - A list of open protocol input network variables
    - Name / SNVT type / purpose
  - A list of open protocol output network variables
    - Name / SNVT type / data description
  - Binding Information
    - Name / SNVT type / bound location

# Sample Device Document

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Building 1, AHU 17

Domain=11, Subnet=5, Node Number=12

## Input Network Variables

OAT_OS	SNVT temp_p	Calibration Offset
DAT_SP	SNVT temp_p	DAT Set Point
FAN_OR	SNVT switch	Fan Override
OCC_Cmd	SNVT occupancy	Time Schedule Input
MAT_ITC	SNVT_seconds	MA Loop Integral Time Constant



# Sample Device Document

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## Output Network Variables

OAT	SNVT temp_p	Outside Air Temp, Cal Value
DAT	SNVT temp_p	Discharge Air Temp, Cal Value
FAN_STAT	SNVT count	Fan Status (1=On)
FAN_ALRM	SNVT count	Fan Alarm (1=Alarm)
MA Dmpr	SNVT_lev percent	MA Damper Position in percent

## Binding Information

Cooling Valve Posn	SNVT lev percent	Bound to Chiller Controller
StPr Set Point	SNVT press p	Bound from Data Mgr

# Sample Device Document

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- With the interface document and the as-built drawings to identify the physical I/O and sequence of control, the enterprise level vendor can define what functionality will be available from the enterprise level HMI.
- This review is very important.

# First Phase

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- The enterprise level for the new system does not have to be a full featured portal or HMI.
  - It must provide for basic operation of the system
  - It must provide for engineering functions associated with the new system.
  - Even after the new system is connected to the existing system, this HMI will be required to service the new building control system.
  - The HMI can be full featured in parallel with the central HMI.

# Second Phase

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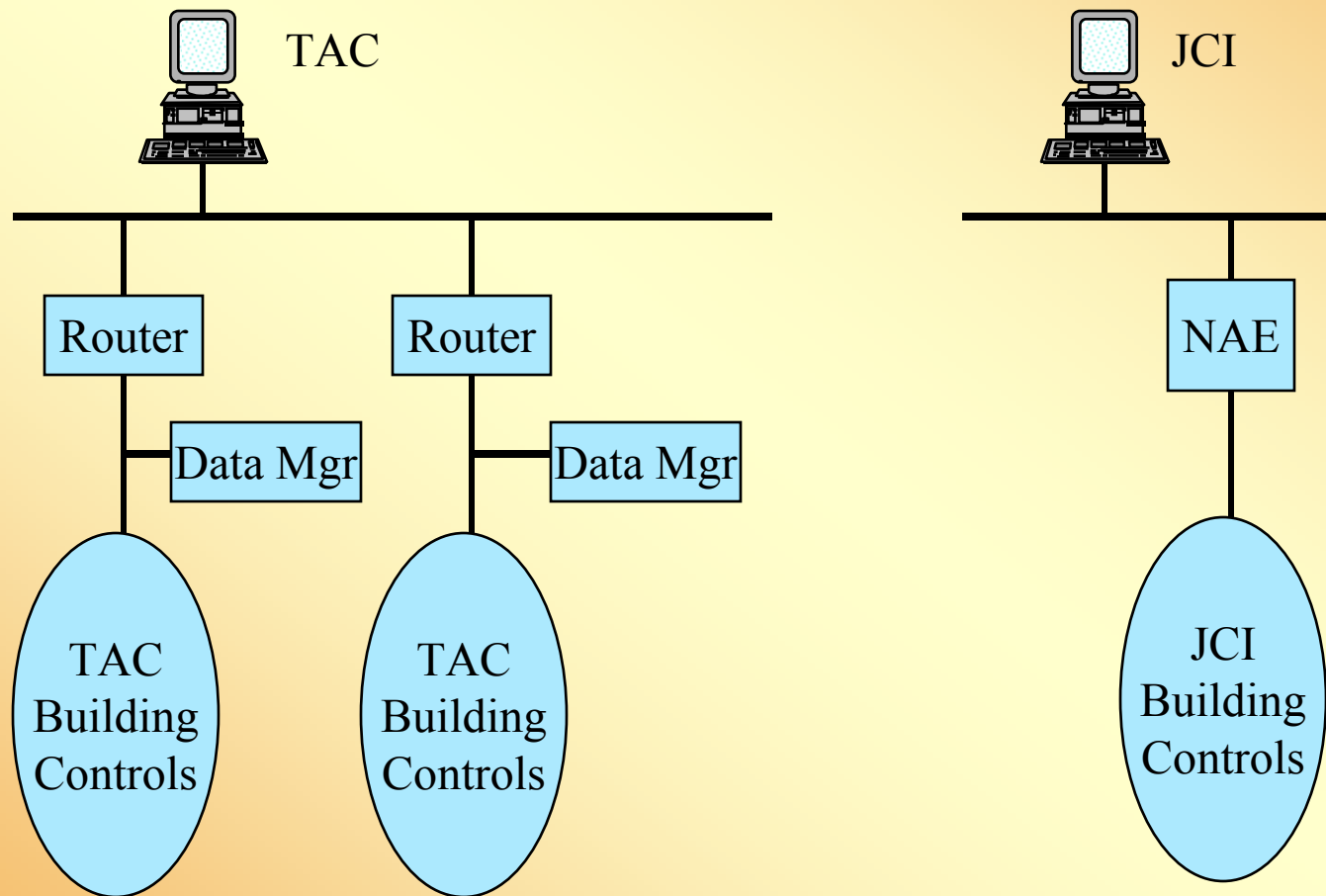
- When the new building system is complete and fully functional, it is time for the connection to the existing system.
- The final data flow requirements will determine how the connection is made.
  - Does data have to flow from device to device, existing system to new system?
  - What operator functions belong to the primary HMI?
  - What operator functions belong to the secondary HMI?

# Example

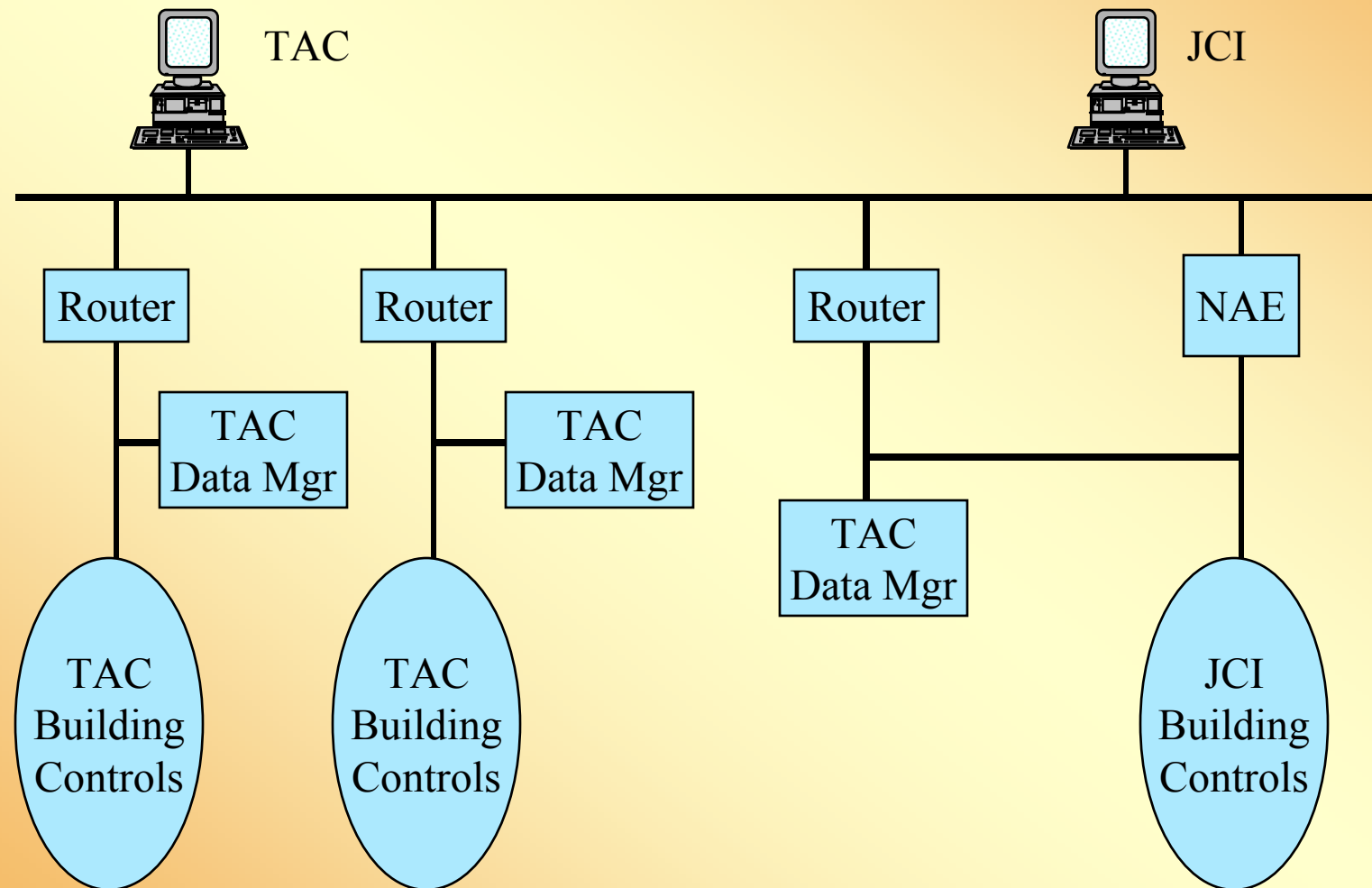
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- Let us assume that you have an existing TAC system in multiple buildings and the new building control system has been awarded to Johnson Controls.
- Both systems are based on the LonTalk open protocol.

# Example-Before Connection



# Example-After Connection



# The Connection

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- With the addition of the new router:
  - All Data “that has been exposed” in an open protocol format can move between the systems (Think about this statement for a moment!)
  - The TAC HMI can read and write to all variables in the JCI devices that have been exposed in an open protocol format.
  - The JCI Workstation becomes a service platform for the JCI building controls but it is not used for day to day operations.
  - The TAC HMI is expected to serve as the primary HMI.



# Some Critical Functions

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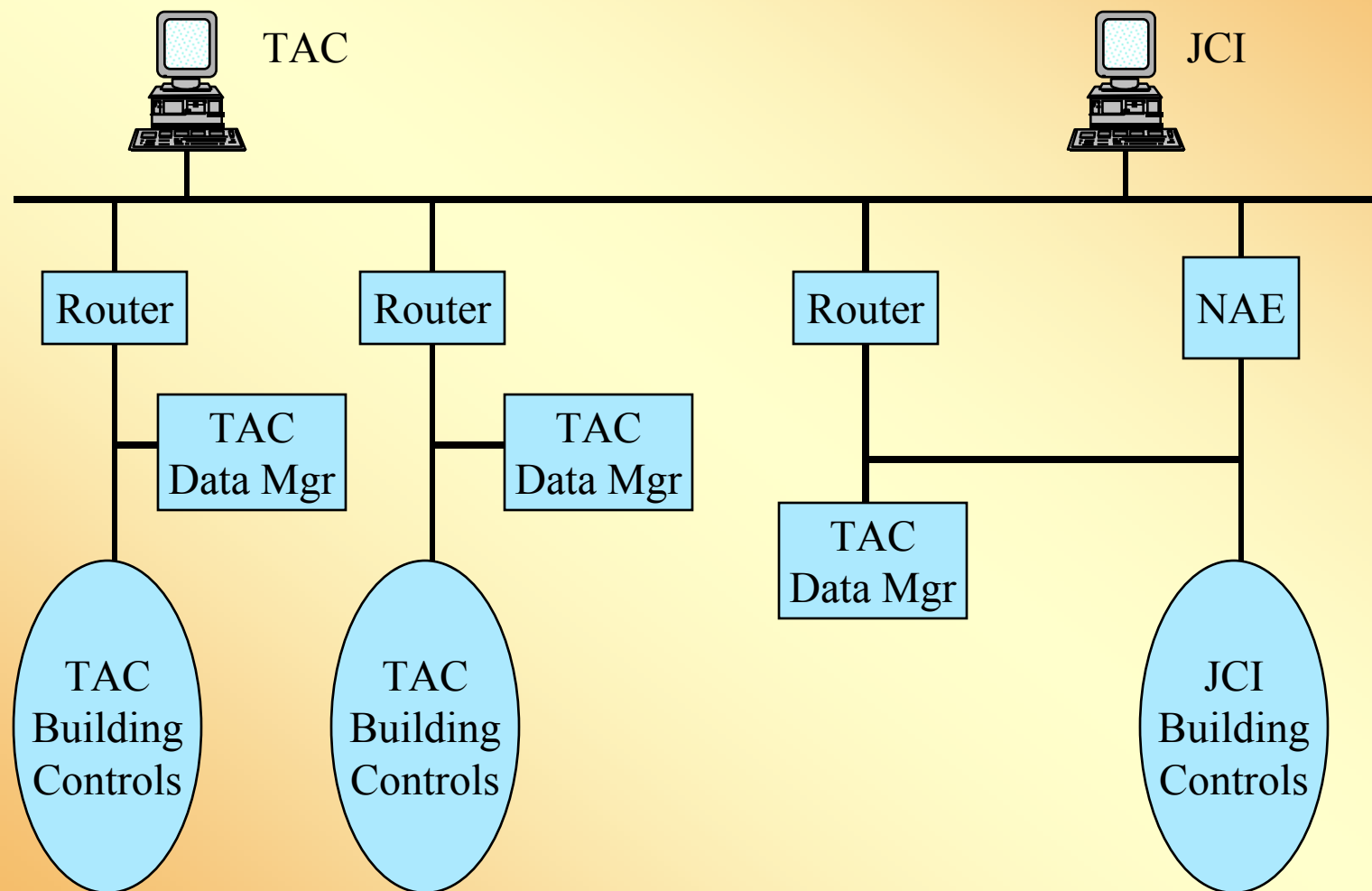
- At this time three critical functions are “owned” by the primary HMI vendor
  - Time schedules
  - Trend data extraction
  - Alarm handling

# Some Critical Functions

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- We have two possible solutions
  - We can move these functions to the computer level of the primary HMI
  - We can use a Data Manager device from the primary HMI vendor to support each new system
- There is a lot of emotion on this issue
  - CERL has chosen to recommend moving the functions to the computer level
  - Many DDC Application Engineers do not recommend making the PC part of the control system....it should just be the human machine connection point.

# With a Data Manager

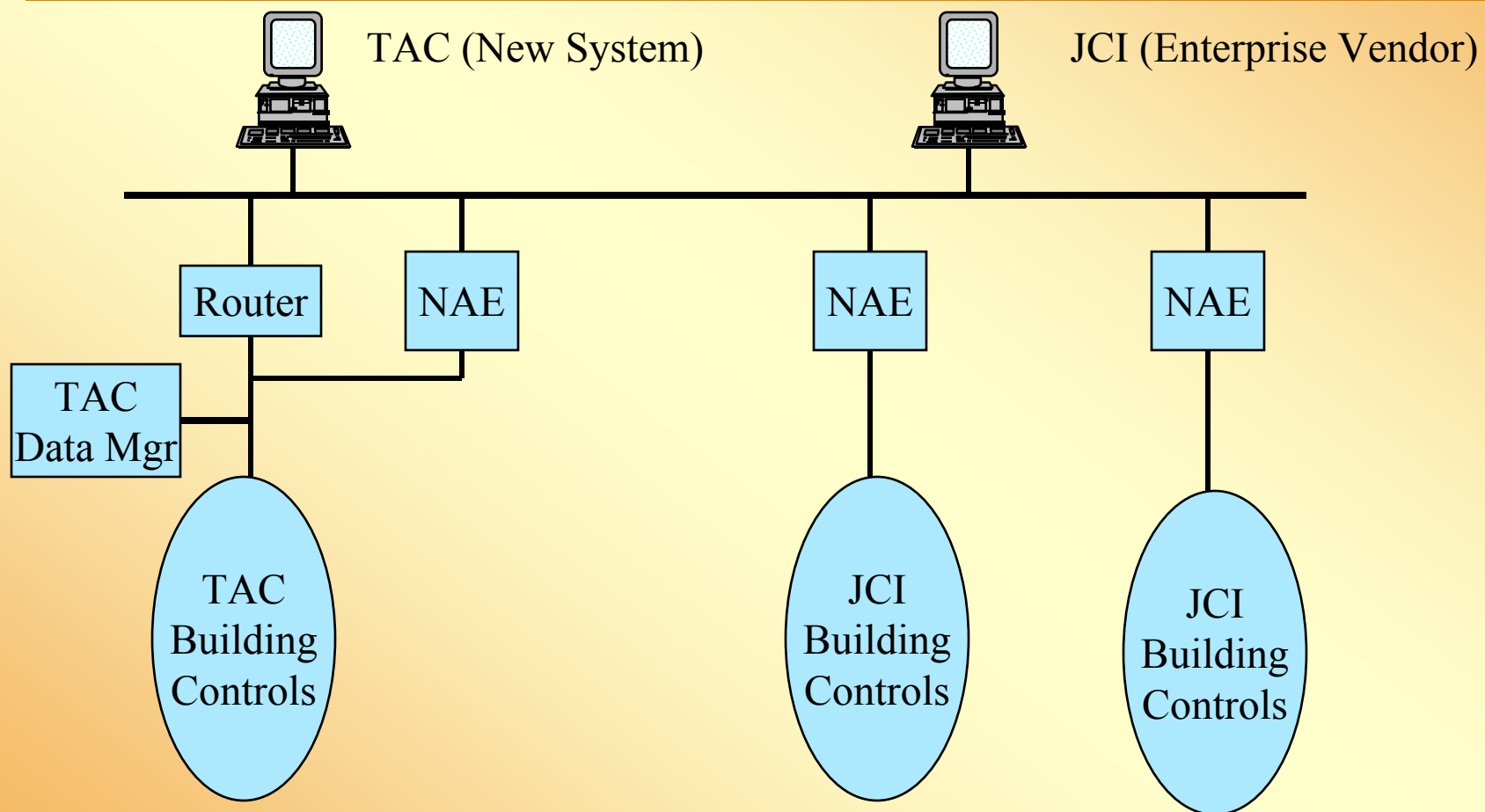


# The Data Manager

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- Logic Only Device
- Location for time schedules to support JCI applications
- Trend logger for data from JCI devices
- Alarm processing unit: receives binary alarm data from JCI devices, attaches text messages and priorities and forwards to HMI.

# An Opposite View



# An Opposite View

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- Is this view Johnson Controls is the enterprise level vendor and the new building is being provided by TAC.
- The NAE device is a combined router and data manager device.

# Just a Reminder

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- The new building applications must be designed to allow open protocol execution of overrides.
- Calibration and tuning parameters must be exposed as open protocol variables.
- Other application variables must be exposed as open protocol variables.
- All data to be viewed or trended must be exposed as open protocol variables.
- A application concept for redirecting control of time schedules from the new building HMI to the primary HMI must be incorporated.

# Just a Reminder

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- The owner and enterprise level vendor must thoroughly review the interface document to ensure that the desired functionality can be implemented when the connection is made. This needs to be done before the new system vendor is released.



# The Concept of Operations

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- If the owner takes full operational control of both systems, this becomes more a matter of training than a specific plan.
- If the owner relies on the vendors to service the systems, a concept of operations is very important.

# The Concept of Operations

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- Any time the supporting vendor for the new building system makes a change, this will generate additional tasks for the HMI vendor. There needs to be processes defined.
  - Adding devices
  - Application changes
  - Network management changes

# The Challenges

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- You are working in a two vendor environment. Avoiding conflict and transfer of responsibility is essential.
- The details relating to “openness” within the new building system have to be well defined.
- Implementation of “openness” within the new building control system is not the current way of doing business for the controls industry.

# Interim Summary

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- Planning and specifying an open system is not a technically complex task but there is a lot of detail that has to be attended to in order to avoid a loss of functionality or the need to rework certain tasks during and after “connection”.
- The multi-vendor environment is also a challenge for the acquisition phase of any open system environment. We have to manage this environment carefully.
- Last but not least, the operational concept to be in place after construction is very important.

# Specifications

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- Initial Enterprise System and Buildings
  - 13800/13801 for enterprise system
  - 15951 for the buildings
- New Building to be added to the system
  - Hybrid 15951 and 13801
  - There is a small HMI with the new building
  - Needs to emphasize completeness and post connection functionality
- The Connection Process
  - Could be part of the 13801 but is not currently

# A Case Study

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- Fort Sill in Lawton, Oklahoma
- CERL Specifications
- Managed by Huntsville
- Enterprise Level System
- 16 Initial Buildings, HVAC
- Post wide demand control
- Other buildings under construction by other vendors to be integrated

# A Case Study

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- Key Element early on was the Factory Test
  - Built a mockup of multiple building control systems connected to the HMI
  - Validated basic DDC functionality
  - Demonstrated how the building controls applications supported an independent HMI even though both were provided by the same vendor.

# A Case Study

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- New rules on connecting to a DOD WAN have been interesting and slowed progress but the open system concept is going as planned.
- We have just started discussions on the connection of the “other buildings” to the enterprise level system.



# I Predict

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- The enterprise level system will work well once we get past the IT assessments.
- The 16 initial buildings will be fully commissioned and work smoothly with the enterprise level system.
- All functionality will be proven to be open during the final functional testing.

# I Predict

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- When we proceed to connect the “other buildings” to the enterprise level system we will find issues that have to be resolved.
- When the planning and specifying of the other buildings was accomplished, we were not as knowledgeable as we needed to be on how to “prepare for the connection”.
- At Energy 2006 we can have a report!

# Some Final Thoughts

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- Although BACNet and LonWorks have been around for over 15 years, the industry is still in its infancy when it comes to open systems.
- Designing and installing open systems is not mainstream. Successes have always been driven by a “champion” and that champion is typically part of the owner’s organization.

# Some Final Thoughts

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- DDC contractors typically earn the majority of their revenue/profit from their installed base. Open systems has the potential to put downward pressure on the contractor's revenue stream.
- Owner's will be the drivers of change and business models will change.

# Some Final Thoughts

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- A well engineered and fully commissioned control system can contribute significantly to more efficient use of energy.
- This is an area that deserves everyone's attention...owner...contractor...vendor.
- See you next year for round 3!